REMARKS

I. Introduction

In response to the Office Action dated December 9, 2002, claims 3 and 10 have been cancelled, claims 1, 4-6, 8, 9, 11-14 and 16 have been amended and new claims 35 and 36 have been added. Claims 1, 2, 4-9, 11-36 remain in the application, however, claims 18-34 have been withdrawn from consideration. Re-examination and re-consideration of the application, as amended, is requested.

II. Claim Amendments

Applicants' attorney has made amendments to the claims as indicated above. Particularly, independent claim 1 has been amended to recite a silicon substrate and wherein the graded gallium nitride layer has a net compressive stress. Claim 1 has also been amended to eliminate that the graded gallium nitride layer is formed from a supply of at least one precursor in a growth chamber without any interruption in the supply. Dependent claims 11-14 have been amended only to clarify the claim language in view of the §112 rejection, discussed below. Minor amendments have also been made dependent claims 4-6, 8, 9 and 16 to be consistent with these amendments and new claims, discussed below.

III. New Claims

New claims 35 and 36 have also been added.

Claims 35 and 36 depend from claim 1. Claim 35 incorporates a portion of old claim 1 reciting the graded gallium nitride layer is formed from a supply of at least one precursor in a growth chamber without any interruption in the supply. (Dependent claims 4-6, 8 and 16 have been amended to properly depend from new claim 35.) Claim 36 recites that the graded gallium nitride layer is at least approximately 0.55 μm thick. For support, see paragraphs [0031] of the application as filed. No new matter is involved.

IV. Non-Art Rejections

In paragraphs (3)-(4) of the Office Action, claims 11-12 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. In paragraph (5) of the Office Action, claims 13-14 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

In response Applicants have amended these claims to overcome the rejections. Support for these amendments is found at paragraph [0024] of the application as filed. No new matter is involved.

In paragraph (6) of the Office Action, claim 1 was rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. The Office Action asserts that the term "substantially" is indefinite as used in the phrase, "a substantially continuous grade".

In response Applicants submit that the term "substantially" is not indefinite because one of ordinary skill in the art would know what is meant by "a substantially continuous grade" and in view of the guidelines provided in the specification. The term "substantially" is often used in conjunction with another term to describe a particular characteristic of the claimed invention. It is a broad term. In re Nehrenberg, 280 F.2d 161, 126 USPQ 383 (CCPA 1960). The court held that the limitation "to substantially increase the efficiency of the compound as a copper extractant" was definite in view of the general guidelines contained in the specification. In re Mattison, 509 F.2d 563, 184 USPQ 484 (CCPA 1975). The court held that the limitation "which produces substantially equal E and H plane illumination patterns" was definite because one of ordinary skill in the art would know what was meant by "substantially equal." Andrew Corp. v. Gabriel Electronics, 847 F.2d 819, 6 USPQ2d 2010 (Fed. Cir. 1988). See MPEP §2173.05(b), subsection D.

V. Prior Art Rejections

In paragraphs (7)-(8) of the Office Action, claims 1-15 were rejected under 35 U.S.C. §102(b) as being anticipated by Edmond et al., U.S. Patent No. 5,739,554 (Edmond). In paragraph (9) of the Office Action, claims 1-17 were rejected under 35 U.S.C. §102(b) as being anticipated by Redwing et

al., U.S. Patent No. 5,874,747 (Redwing). In paragraphs (10)-(11) of the Office Action, claims 16-17 were rejected under 35 U.S.C. §103(a) as being unpatentable over Edmond in view of Goetz et al., U.S. Patent No. 6,441,393 (Goetz).

Applicants respectfully traverse these rejections for the reasons set out below.

Independent claim 1 is directed to a semiconductor film, comprising a silicon substrate and a graded gallium nitride layer deposited on the silicon substrate having a varying composition of a substantially continuous grade from an initial composition to a final composition wherein the graded gallium nitride layer has a net compressive stress.

The cited references do not teach nor suggest these various elements of Applicants' independent claim.

Edmond merely describes a double heterostructure for a light emitting diode comprising a layer of aluminum gallium nitride having a first conductivity type; a layer of aluminum gallium nitride having the opposite conductivity type; and an active layer of gallium nitride between the aluminum gallium nitride layers, in which the gallium nitride layer is co-doped with both a Group II acceptor and a Group IV donor, with one of the dopants being present in an amount sufficient to give the gallium nitride layer a net conductivity type, so that the active layer forms a p-n junction with the adjacent layer of aluminum gallium nitride having the opposite conductivity type. However, Edmond lacks any discussion about a graded gallium nitride layer having a net compressive stress and deposited a silicon substrate. Instead, Edmond teaches away from Applicants' invention because it teaches only a graded layer on a silicon carbide substrate.

The Office Action acknowledges that Edmond is silent to the graded layer having a net compressive stress, but asserts that it is inherent to have a net compressive stress because "differences in lattice constant throughout the graded layer inherently causes compressive stress". Applicants respectfully disagree.

First, Applicants submit that the teaching of Edmond clearly suggests thin buffer layers. For example, FIG. 3 illustrates an SEM photograph disclosing dimensions of all layers except the buffer layer, presumably because it is insignificantly thin. The thinnest layers mentioned are the 1000 Angstrom heterostructure layers; it is reasonable to assume that the buffer layer taught by Edmond is thinner than this. See column 8, lines 21-29. This is also consistent with the thin depiction of the

buffer layer 42 in FIG. 2 which is shown significantly thinner than the n-GaN layer 43 and the heterostructure layers 45-47.

Second, Applicants submit that the interaction of a thin buffer layer on a silicon substrate is entirely different from the interaction of a thin buffer layer on a silicon carbide substrate. As taught in the application at paragraph [0038] referring to FIG. 9, "the stress measured for such a film grown using a thin AlN buffer or a thin grade is typically tensile, on the order of 500 MPa; cracks are present in such films, as shown". [emphasis added] Thin buffer layers as suggested by Edmond would not produce a net compressive stress on a silicon substrate as claimed.

Applicants submit that because each and every element of the claimed invention is not taught by Edmond, the present §102 rejection is overcome.

Redwing merely describes a green-blue to ultraviolet light emitting semiconductor laser having a top contact, a Bragg reflector, cladding layer, active layer, cladding layer, buffer, substrate, bottom contact and a passivation layer. The key aspect is a Ga*N material on a base structure comprising a SiC substrate selected from a group consisting of 2H-SiC, 4H-SiC and a-axis oriented 6H-SiC. Furthermore, the cladding layers have larger band gaps than the active layer and are complimentarily doped. However, like Edmond, Redwing lacks any discussion about a graded gallium nitride layer having a net compressive stress. In addition, Redwing does not teach or suggest a graded gallium nitride layer on a silicon substrate.

In addition, Redwing provides an example of a thin gallium nitride layer on silicon carbide (~1000-2000 Angstroms). See col. 25, lines 8-11. However, as discussed above, tensile stresses not compressive stresses are known in thin gallium nitride layers (even graded layers) on silicon. Consequently, Redwing's teaching of a thin gallium nitride layer on silicon carbide teaches away from a graded gallium nitride layer on a silicon substrate and having a net compressive stress as presently claimed.

Applicants submit that because each and every element of the claimed invention is not taught by Redwing, the present §102 rejection is overcome.

Finally, Goetz merely describes a semiconductor device is provided having n-type device layers of III-V nitride having donor dopants such as germanium (Ge), silicon (Si), tin (Sn), and/or oxygen (O) and/or p-type device layers of III-V nitride having acceptor dopants such as magnesium (Mg), beryllium (Be), zinc (Zn), and/or cadmium (Cd), either simultaneously or in a doping

superlattice, to engineer strain, improve conductivity, and provide longer wavelength light emission. However, like Edmond and Redwing, Goetz lacks any discussion about a graded gallium nitride layer having a net compressive stress.

Further, Goetz teaches buffer layers 12, 22 and 52 are low temperature buffer layers. See col. 3, lines 32-35, col. 4, lines 10-11 and col. 4, lines 51-53. However, low temperature buffer layers are known to cause tensile strain when used on silicon substrates. See, e.g. page 3, lines 11-13 of the application as filed. Thus, Applicants submit that Goetz's teaching of such low temperature buffer layers teaches away from a graded gallium nitride layer having a net compressive stress because these buffer layers would cause a tensile strain.

Even when combined, Redwing and Goetz would teach away from Applicants' invention. For example, the combined references would teach a thin low temperature buffer layer. As discussed above, both the thin layer and the low temperature application would induce a tensile stress rather than a net compressive stress in a graded gallium nitride layer on a silicon substrate.

Moreover, the various elements of Applicants' claimed invention together provide operational advantages over Edmond, Redwing, and Goetz. For example, the use of silicon substrates rather than sapphire or silicon carbide substrates in the production of semiconductor will result in additional cost savings. See paragraph [0007] of the application as filed. In addition, Applicants' invention solves problems not recognized by Edmond, Redwing, and Goetz, such as producing a net compressive stress in a gallium nitride layer disposed on a silicon substrate.

Thus, Applicants submit that independent claim 1 is allowable over Edmond, Redwing, and Goetz. Further, dependent claims 2, 4-9, 11-17, 35 and 36 are submitted to be allowable over Edmond, Redwing, and Goetz in the same manner, because they are dependent on claim 1 and thus contain all the limitations of the independent claim. In addition, dependent claims 2-9, 4-9, 11-17, 35 and 36 recite additional novel elements not shown by Edmond, Redwing, and Goetz.

VI. Conclusion

In view of the above, it is submitted that this application is now in good order for allowance and such allowance is respectfully solicited. Should the Examiner believe minor matters still remain that can be resolved in a telephone interview, the Examiner is urged to call Applicants' undersigned attorney.

Respectfully submitted,

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